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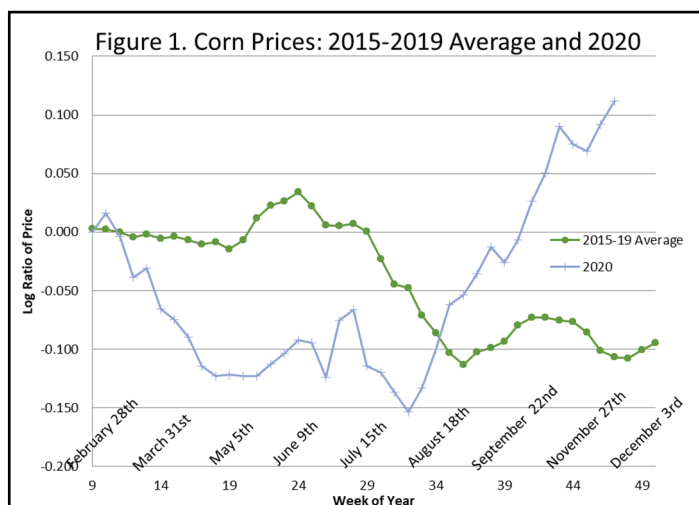
Cornhusker Economics

Surviving Variable Yields and Prices

A marketing strategy focusing on prices from the most recent past, indirectly gives little or no weight to all of the other possible price outcomes. While it is intuitive that the most recent prices are more likely to play a role in our decision-making process, there are other price events that can happen. The seasonal price path from the 2019/2020 crop year was nothing like we have recently experienced. Suppose we entered the 2020's marketing decision using a seasonal approach that considers only the average price series over the past 5 years (2015-19 average), Figure 1. The seasonal average indicates prices at harvest are among the lowest with early summer prices higher. The 2020 price series turned out to be nothing like the previous five-year average. This may have left you wondering what happened and perhaps in an unexpected financial position. This illustration shows us that recent experience does not give us enough information to construct an appropriate risk management decision framework. Price outcomes that have not yet been experienced will likely be the ones that severely hurt the financial health of a farming operation. A better understanding of the price generating process and an improved risk management decision framework are required.

Agricultural production exists in a complex decision environment. Often, farmers do not have the opportunity to directly observe other farmers' decision-making processes. The University of Nebraska-Lincoln has opened the door to observing producers' decision-making process through its unique Testing Ag Performance Solutions (TAPS) program. This program offers yearly competitions in corn, grain sorghum and hard red winter wheat based on maximum profit, maximum yield, and maximum input use efficiency. Participants in TAPS compete in making six types of decisions including the purchasing of crop insurance, seed variety selection, seeding rate per acre, nitrogen and water application and pre-harvest grain marketing. Participants and other farmers following the completion of the competition can view the outcomes, and management decisions, allowing them the opportunity to revise their decision-making strategy for the following seasons.

The TAPS program sets the standard in providing the exposure of profit difference between participating teams due to production and commodity sales choices throughout the growing season. Since each of the competing farms are identical in size, scale, location, market and weather conditions, outcomes are due to the differences in management choices made by the individual teams. The exact impact of the decisions can be directly identified and quantified. Yet, what works in one year with a particular set of yield and price outcomes, is likely to turn out quite differently given a new set of yield and price outcomes being observed in future years. The value of having crop insurance and/or hedging is not identified by one price series, rather it is identified over many production seasons.



The previous year's yield and price outcomes have no bearing on the uncertain future, e.g. drought conditions, trade wars, economic calamity, pandemics, etc. The next unseen rare event may be worse than anything we have seen in the past. Prices and yields can end up in some very uncomfortable places. While unpleasant to think about, rare events can become real and consequently must be dealt with. Failure to consider and protect oneself against rare, financially devastating events increases the chances of farm ruin. Said another way, outcomes from choices related to crop insurance and hedging change from year to year. Last year's, or one season's outcome (or five years) is not enough to judge the effectiveness of crop insurance and/or a hedging strategy. Decision making under uncertainty cannot be viewed through a small number of observations.

A farmer gets the opportunity to plant a crop each season. Given that farmers plan on farming continuously for many years (i.e., survive) and depending on when they start farming and decide to retire, they could farm 40 or more seasons. In addition, the farm may be transferred to children, siblings or close relatives, neighbors and friends to farm for another 40 or more seasons. Producers often relate themselves to what generation of farmer they are. Surviving and prospering matters.

One of the hardest things to do is to place the proper amount of weight on events that are 1) financially devastating and 2) are rare. However, it is the combination of these events that creates the most stress on farm survival. At the beginning of each year, farmers make decisions that affect both yield and price outcomes. For example, consider a scenario where one farmer buys crop insurance while another one does not. Suppose a drought or other adverse weather event occurs making the crop insurance a real asset. Both farms' financial paths after the rare event will be decidedly different, with one possibly not surviving. The same idea happens when the bad event does not occur. The farmer who paid the insurance premium loses out with a higher cost of production. But as the seasons go by, eventually a rare financially devastating event comes along, causing the financial path of the farmer who purchased crop insurance to be substantially different than the non-insured farmer, a path where the non-insured producer may not survive. Since premiums are subsidized, the insured producer is likely to receive more back than was paid in premiums.

This same principle can be applied to pre-harvest hedging. Using the information from Figure 1 corn farmers who sold 2020 corn at harvest (week 46) would have received about a 9.2% higher price than the beginning price on the chart. This is a much higher price, than those who pre-priced corn in week 24, which was 9.2% lower than the beginning price. Now let's use the same two marketing dates for the average five-year price series. The harvest market week 46 would have resulted in a discount price of 10.1% relative to the

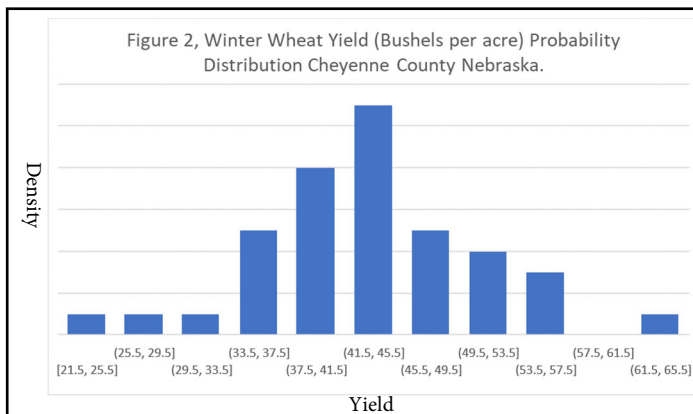
beginning average price. The early season pricing would have resulted in a price that was a 3.4% premium to the beginning average. Not selling until harvest worked in 2020 but not in the previous five-year average. As we enter 2021, we cannot predict where harvest sales will be and they may be the worst price outcome or the best price outcome.

As stated earlier, farmers only realize a limited number of yield and price outcomes, they will never experience all possible outcomes. One of those never before experienced, rare outcomes may happen next year. This is where the old saying, "Just because it hasn't happened yet doesn't mean it won't," or alternatively "absence of evidence is not evidence of absence" represents a cornerstone in decision making under uncertainty. Considering bad, yet not realized, events is difficult, but when farm survival is on the line, it must be considered. I am often reminded of this when I hear farmers say, "I have never seen that before." Usually, it is the less experienced farmers making this statement. Listening to family members about past challenges can be some of the best advice you can get.

The TAPS competition is a single year game, with competition winners announced at the end of the production year. This single ranking does not highlight long-run strategic decision making. The TAPS most profitable farm is for a single season, with each new season likely having different results. Unlike the contest real farms have to be profitable more often than not, they are what economists call playing a repeated game. To be clear, we as the authors of this article do not view farming as a game but use the terminology developed by mathematicians to study and make inferences about real life circumstances. Said another way, to make money farming you must survive; therefore, farmers make decisions in the repeated game environment.

Let us view the twenty-contestant 2020 TAPS hard red winter wheat contest from Sidney, Nebraska in a repeated game context with decisions made under the condition of uncertainty. At planting, neither yields nor prices are known, making them uncertain. Both yields and prices at this point while not known with certainty, could be described as each one's outcome within a likely range. One possible way to think of this is to use historical information as the likely ranges. This is depicted in Figure 2 for wheat in Cheyenne County, Nebraska.

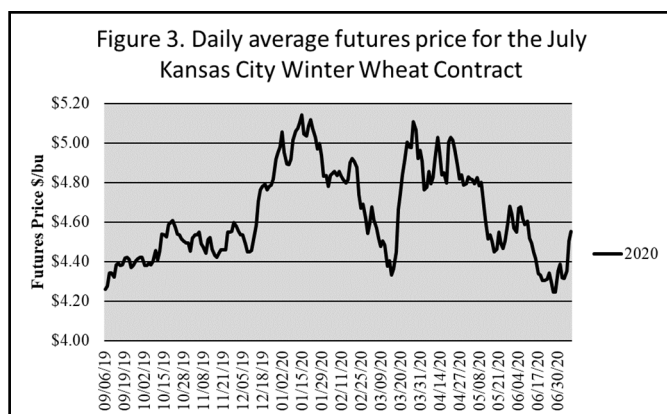
From this figure, it can be seen that a wheat yield between 41.5 bushels per acre (bpa) and 45.5 bpa represents the most likely outcome. As one moves either left, decreasing yields, or right, increasing yields, relative to the center point, the likelihood of experiencing these yields diminishes. The idea of the rare, financially dev-



astating events we have referred to earlier are represented by those located at the left tail of the figure. Each new production year is like making a single draw from this figure with that draw becoming that season's realized yield. Price is drawn from its own figure or distribution and is explained below in further detail. If each year a farmer in Cheyenne County Nebraska draws from this yield distribution, a farmer who farms for 40 seasons would experience 40 different draws. With that number of draws the chances are high they would realize both low and high yields. Knowing this should have an effect on decision making under uncertainty, especially when it comes to crop insurance participation. From the figure, the average yield is 43 bpa. Notice the variation around the average yield. Final farm yields in this figure range from a low of 21.5 bpa to a high of 65.5 bpa. For 2020, TAPS contestants' average production history (APH) was 43 bpa, but actual yields ranged from 15 to 29 bpa. It could be said that for the 2020 contest year yields were on the rare side.

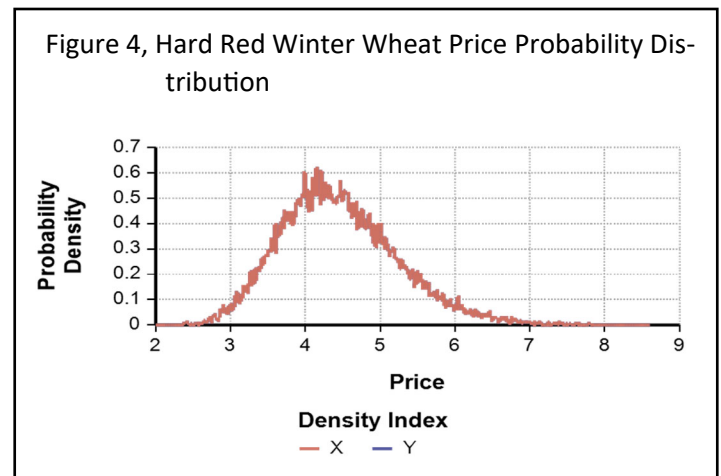
Before moving on and working through some examples about how this variation can affect profits, it will be helpful to understand price variations.

At the time of planting, hard red winter wheat prices, Figure 3, were near \$4.48 per bushel, i.e., the crop insurance projected price. As time passed new information entered the market and prices fluctuated.



The record of these fluctuations has formed a price series for the year with an ending price of \$4.45 per bushel, i.e. the crop insurance harvest price. The price path realized in 2019/20 represents one path of an infinite number of others. It could be said that Figure 3 is a graphical representation of one possible price series. Much like the yield distribution, the prices in the series can be captured based on probable occurrence. Figure 4 is illustrative of such a price distribution and now captures the same idea of uncertainty as the distribution of possible yields, but for price.

From Figure 4, we can see that prices can drop below \$3.00 per bushel and can exceed \$6.50 per bushel. The price distribution in Figure 4 contains all of the observed hard red winter wheat prices for the 2019/20 market year. At the beginning of each year, the exact upcoming seasonal commodity market pattern is not known but begins to reveal itself as the year proceeds. This makes marketing decisions burdened with uncertainty and often leads to inaction.



Now, let's apply this information and see what we can learn from the 2020 TAPS hard red winter wheat competition. The profit winner had the 5th highest per acre cost of production and highest yield (29.2 bpa) with no pre-harvest marketing. Their wheat was of such a quality that it received a protein price premium of \$0.30 per bushel. But would they have won if yields were at APH levels, 43 bpa? What if prices declined to around \$3.00 per bushel at harvest? How would those who hedged or had crop insurance perform?

The answer is, "no" they would not always be the most profitable. Under different price and yield realities, the most profitable farm in the TAPS contest changes. Assume for a minute that each of the twenty farms in the 2020 TAPS hard red winter wheat competition had each realized an additional 22 bpa. With the additional production, the group average is equal to the APH of 43 bpa. By giving each

contestant an additional 22 bpa, we maintain the same yield rankings. With no other changes to inputs, price distribution or marketing strategies, the lowest cost of production farm would have been the most profitable. The original winner now takes 2nd place, the original

3rd place holder now takes 1st place and the original 2nd place holder now takes 5th place. The biggest gain was Team 7 which went from 15th to 9th while the biggest loss was Team 8 which went from 5th place to 13th place. Under more normal yields and the price 2019/20 path, a high cost of production farm could not achieve the highest profit by “out marketing” their lower-cost competitor. However, just as discussed, next year hedging may turn out to be the difference between profit and loss.

How should we approach decision making under uncertainty? A tough question. A couple of thoughts come to mind. Risk management strategies are intended to protect you from financially devastating rare events. Not observing these events in any given year is just as powerful as observing them. Not realizing bad outcomes does not invalidate the strategies designed to mitigate them. Successful farming is an exercise in making fewer/less severe mistakes and optimizing the things that work. While mistakes are inevitable the idea is to make fewer and financially less devastating choices. Just remember just because it has not happened yet doesn't mean it won't. You need to be ready for when things do happen.

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